Lion Fish Classification Problem:

A Comparison of Three Pretrained models & one from scratch model

CP3468: Artificial Intelligence

Dr. Emad Mohammed

Manreep Sran (200298250)

George Salib (169044262)

Amanjot Singh (210934140)

Abstract

Through the training of 3 pretrained CNN models and one model of our own design, we can see that the VGG16 model performed the best, with an accuracy of nearly 82%.

Introduction

Lionfish are one of the most dangerous invasive species in the world. Their introduction to the Gulf of Mexico, the Caribbean Sea, and the North Western Atlantic has put countless species of fish at risk of becoming endangered. Due to their lack of natural predators in these regions, as well as abundant food sources for them, Lionfishes have been outcompeting native fish species (Fisheries 2022). Lion fish also consume many smaller species of fish, increasing their threat to native fish. Upwards of 79% of a reef's population dies out when invasive Lionfish start to inhabit it (Fisheries 2022). The problem has reached such a level that various governmental organizations of those regions and non-profit groups have started to mass cull Lionfish populations. The problem with this approach is that it is hard to know where all the Lionfish in an area are, and even harder to make sure an area has been cleared of them.

This is why image classification AI is useful in the fight against Lionfish. To completely check an area, oftentimes underwater drones are used with their ability to record video. They can properly sweep a reef or other habitat and capture video that can be analyzed to locate Lionfish. However, this results in hours of footage that are usually messy and confusing. As such, the task of locating Lionfish in these videos is a difficult and boring task for humans to do. With manpower being one of the most important resources with far better uses than watching and rewatching hours of underwater footage, the use of AI image classification to analyze each frame of the video is far more efficient.

Similar Solution

Previous attempts at creating Lionfish classification AI models have had much success. Most attempts have pursued the use of pre-trained models, modified with transfer learning, to fit the problem of classifying Lionfish.

In the Martínez-González et al. 2021 paper, "Deep learning algorithm as a strategy for detection of an invasive species in uncontrolled environment.", the researchers compared the results of two pre-trained models, YOLOv4 and SSD-mobilenet-v2. Both were trained with transfer learning and used cross validation to increase the accuracy of the models. The most accurate model they found was YOLOv4 with cross validation 5. This model achieved a 79.15% accuracy.

Another example of researchers using models for fish detection is in the paper “Temperate fish detection and classification: a deep learning based approach” (Knausgard, 2021). They used transfer learning in order to train their model in order to identify and classify temperate fish without preprocessing. The researchers in this paper used YOLOv3 (for detection) and CNN-SENet (for classification).

Methodology

The first set of an image classification problem is finding and preparing a good image dataset. Without a properly labelled and large set of training, testing, and validation images, it is highly difficult to create models to solve such a problem. Our dataset[1] comes in the TFrecord (TensorFlow Record) format, a format used to store data in binary records and that works quickly and efficiently with TensorFlow and Keras API (*Keras documentation: Creating*

[1] See Appendix.

TFRecords). This is because TFrecord allows for parallel I/O. The dataset is a total of 957 training images, 97 validation images, and 44 testing images. Certain images in this dataset are augmented with a rotation of 15 degrees and/or a sheering of 10 degrees. These augments help diversify the dataset, allowing for more robustness in the models.

For the three pretrained models required by the assignment, we chose VGG16, VGG19, and Xception. These models were chosen due to their high accuracy rating according to Keras' website[2]. Each of these models are CNNs that require transfer learning to fit our problem. To perform transfer learning, most of the layers of a model need to be frozen, leaving only a few layers to be trained. These frozen layers contain the bulk of the data of the model, so when training the remaining layers, we are just fitting them to work for the problem.

Training models large amounts of processing power and time, especially so with a dataset as large as ours. As such, we kept our training to 10 epochs. This represents 10 passes through the training set of images, with each epoch helping to refine each model's ability to identify Lionfish in images. Each of the models is also set to track accuracy, as it is an important way to get an understanding of the efficacy of each model.

For the from-scratch model, we created a Sequential model with 4 layers and trained it on the dataset. First is a Convolution 2d layer with 32 filters, applying them over the input image. Then a Max Pooling layer which reduces the input image's width and height. Followed by one more Convolution 2d layer, this time with 64 layers, and then another Max Pooling layer. These four Convolutional Layers help the model extract the features of each image it looks at to better classify whether or not it fits the Lionfish class. The model also features a dropout layer that helps with overfitting. Given the relatively small amount of data, at least compared to other

[2] https://keras.io/api/applications/

models, overfitting is a real problem with our model, so the dropout layer is helpful in preventing it.

Conclusion

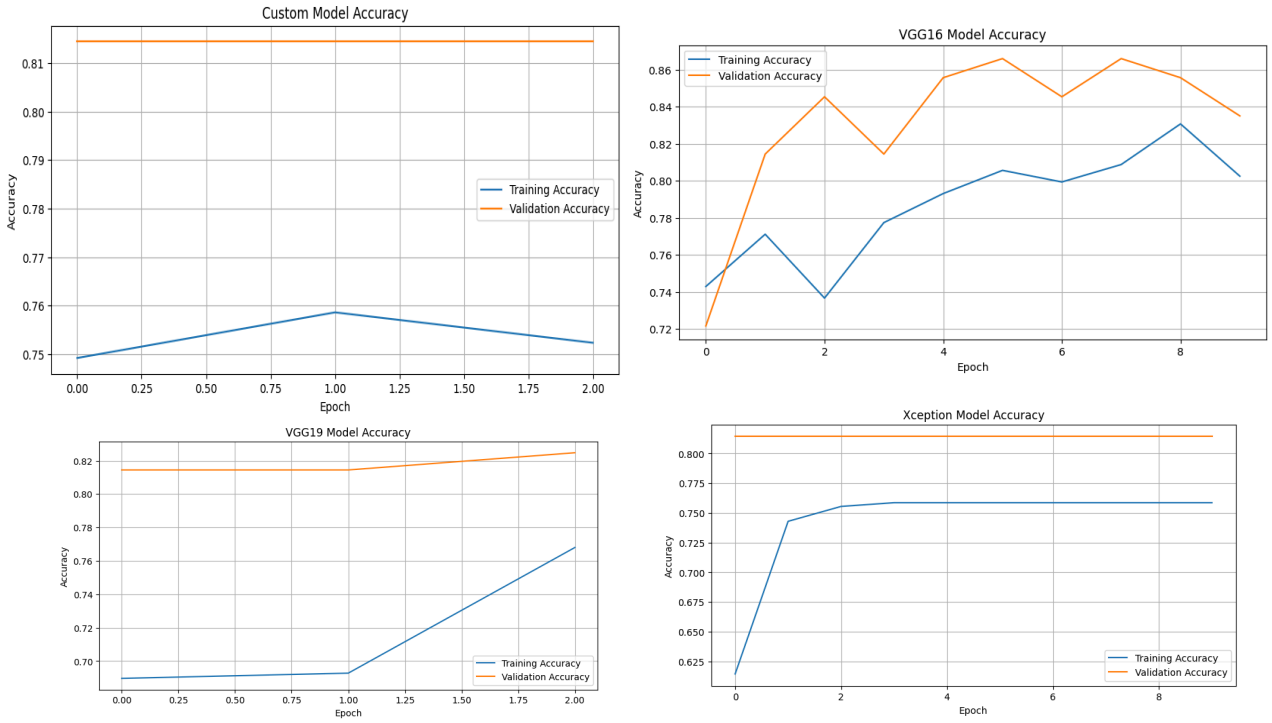

Figure 1: Accuracy graphs of all them model's training

Each model was able to accurately classify whether or not an image contained a Lionfish within it. Plotting out the data from the training sessions, we can see the way accuracy increased or decreased over the various epochs a model went through. As can be seen in figure one, the accuracy of each of the various models was highly different. The VGG16 model was the most accurate out of all of them, having a peak accuracy of 0.83. This makes it the most accurate model of the 4.

Appendix

Dataset: https://universe.roboflow.com/gregory-alan-uhland-jr/lionfish-k1zkz/dataset/10

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